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Adaptation of Biomass Based Thermal Energy Generation of Sri Lankan Manufacturing Sector: Paragon for Policy Development

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Abstract

Biomass based thermal energy generation has become more popular among the Sri Lankan manufacturers in the last decade due to two core issues like alleviation of fuel cost, contributing towards high manufacturing cost and adaption as green energy source thereby to implement as a climate change mitigation project. Even though this trend prevails currently, there are some ambiguities for the step-in industries related to supply chain of biomass, sources of technical knowhow and maintenance, government policy changes etc. However there are several government (Sustainable Energy Authority, NERD) and non-government organizations (Biomass Energy Association), which involve in promoting biomass as a source of fuel for thermal energy generation, there are many inexplicable problems which will hinder renewable mode of energy generation in future unless a proper study is carried out to determine the highlighted key issues. Therefore, this research is carried out in order to identify the level of adaptability of biomass as a fuel in the local manufacturing sector and corresponding problems, thereby to develop a model which can be utilized for policy development in the future. Methodology consists of several phases; in the first phase, surveys were conducted for different manufacturing sectors, which have adapted this technology recently, through a structured survey which covered supply chain management, maintenance issues, health and safety and history in related to biomass. In the next phase, data gathered through surveys were analyzed based on several aspects. Finally, a paragon model was developed and presented to guide policy developers in future.

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Keywords: Biomass, sustainable manufacturing, climte change mitigation, and green energy

1. Introduction

Sustainable manufacturing has earned more popularity based on several factors like resource depletions, environmental concerns and customers' requirements. Today, most of the manufacturing industries are transforming towards green by incorporating eco-design strategies and sustainable manufacturing concepts to deliver green products and services to their customers. Industries require energy in the entire supply chain of any product from the resource extraction/ generation phase to the end of life phase. Even though most of the energy requirements of the industries are accomplished with fossils fuels today, the need for a shift towards sustainability has paved ways to look into alternative energy sources. Solar power, wind power, biomass, etc. are few of the popular alternative energy sources. Today, biomass has become further popular in the Sri Lankan industries for many reasons. Industries are identified as sustainable manufacturers and their products are recognized as green products due to the usage of environmental friendly energy sources. Biomass is a carbon based mixture of organic molecules of hydrogen, oxygen, nitrogen, and other atoms of alkali, alkaline earth and heavy metals in different compositions of the living, or recently living organisms [1]. Even though there are numerous environment friendly alternative energy sources globally, and locally biomass has a unique place within the industries due to their capability of generating high capacity of thermal energy. Furthermore, biomass is highly desired by the industries since it is considered as a zero emission energy source which has a closed loop in the perspectives of green house gases. Apart form these reasons, fluctuations in the prices of crude oil in the global market, rapidly increasing energy demands, new emphasis on forestry and better forest maintenance, customer requirements, eco-labelling and international standardization

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too stress on the local manufacturers to take initiatives to use biomass for heat generation and other manufacturing processes.

1.1. Energy Consumption in Sri Lanka

As in the case in many developing regions in the world, South Asia too relies on biomass for residential energy consumption, particularly Sri Lanka. The energy requirements of Sri Lankans are supplied by biomass, petroleum, and hydroelectricity. Yet biomass has been used by Sri Lankans since pre-historic times, by the end of 2000 biomass became more popular among this community. Today, approximately biomass caters 47.9%, petroleum caters 43.4%, and hydroelectricity caters 8.7% of the total annual energy demands [2]. Energy demands in Sri Lanka can be classified into three major categories namely: households and commercial, industries, and transports, while household and commercial sector consumes approximately half of the energy supply, while other two consume almost 25% each. It is noticed that the major part of the energy demands of household and commercial sectors come from biomass (approximately 82%). Industries sector utilized biomass for their energy requirements (approximately 68.7%), while transportation sector uses petroleum only for their energy requirements.

1.2. Biomass Energy in Sri Lanka

Approximately 70 per cent of the biomass energy is consumed in the domestic and commercial sectors [2]. Still 80 per cent of the locals depend on fuel-wood and other forms of biomass for their cooking purposes. Today, biomass is utilized on the production of energy for residential, commercial, or industrial applications than for food. Industries like agro sector (tea, rubber, coconut, sugar, etc.), manufacturing sector (brick, tile, lime, etc.), and commercial sector (bakeries, hotels, and restaurants) use fuel-wood as one of the main thermal energy sources. Small-scale industries like pottery, ceramics, chemicals, metals, leather, textiles, laundries, etc. use bio-energy to fulfil their energy requirements. Also, it is observed that these manufacturers will heavily depend on biomass in near future due to the existing issues with the price fluctuations of fossil fuels, GHG emissions, sustainability etc.

1.3. Thermal energy Requirements in Sri Lankan Manufacturing Sector

Statistics reveal that the major component of the energy demand is for thermal energy for industries and domestic uses. In order to cater the thermal energy requirements contribution through biomass is more sustainable. Industries currently import 425,000 tones [2] of petroleum products in order to generate steam or hot air, and the corresponding cost is very high. This can be replaced by fuel wood which is available within the country, and only 65,000 ha of fuel wood plantations will be required with some minimal changes in the existing equipment and facilities. It is obvious that the recovery period of these costs will be very minimal.

This sustainable shifting benefits the industries not only to green their plants, but also to save foreign exchange for the country, for industries in fuel costs, and for fertilizers of leaves replacing urea in billions per annum. In order to achieve these enormous benefits the industries should be motivated in order to use biomass instead of fossils for thermal energy generation.

However biomass is considered as an appropriate alternative energy source for fossil fuels, there are constraints in using biomass. It requires notable amount of investments for the manufacturing industries in order to set up facilities to generate biomass based energy in large scale, where the small and medium scale manufacturers fail to afford. Also, it requires sufficient amount of knowledge on biomass energy generation for designing the plant. Even after designing and implementing the plant proper maintenance should be carried out in order to ensure better performance and safety of the plant and the workers. Apart form these issues in the manufacturers side, there are certain problems with the local planners, policy makers, and the government of Sri Lanka, where they have not given sufficient importance to promote sustainable energy sources like biomass initially. Although the local planners and policy makers initially have not given sufficient importance for biomass as a sustainable energy source, a novel interest in biomass has bloomed in the industries due to the recent technological conversions, crop production, etc. Apart form them numerous socio-economic and environmental benefits created by modern biomass energy technologies like biomass gasification, and biomass based heat and electricity generation too have witnessed the positive growth of biomass energy generation [4].

Since that, today, the local government has proposed several policy initiatives to create an appropriate ambience for the growth of the biomass energy sector. In order to cater the increasing demand for biomass materials Sri Lankan government has introduced an intercrop called Gliricidia [2]. Apart form the government authorities, different other non-government organizations too play a vital role in promoting the biomass energy generation in Sri Lanka.

1.4. Applications and Characteristics of Thermal Energy Generation in Sri Lankan Manufacturing Sector

Biomass is used in local manufacturing industries in order to cater different necessities like thermal energy generation, electricity generation, etc. Brass manufacturing industries use biomass for heat generation at a rate of 120kWh [2]. Rubber related industries produce heat for heaters and boilers. Usually for heaters they generate heat at a rate of 750 kWh, and at a rate between 400 and 1000 kWh. Meanwhile, tea factories generate electricity for their process requirements at a rate of 290 kWh [2]. In all these applications Gliricidia wood chips are used as the combustion material to generate different forms of energy.

Several studies related to biomass have been carried out globally and locally, especially in recent times. An overview of the biomass sector in Sri Lanka is presented in [4]. In this report, the author has presented the energy sources, consumptions, use of biomass energy, recent changes, availability of biomass, etc. Also has briefed the positives and the negative implications of biomass usage in his study. A similar study [5] on the status, trends, and future settings of biomass energy in the Asia-Pacific region analyses the driving

forces influencing the changes and assesses the current situation, and trends as regards biomass energy consumption and the probable scenarios of the development of different biomass energy segments.

Among the major applications of biomass, electricity generation has a dominant place. Few studies have been carried out in related to electricity generation using biomass. [6, and 7]. Sugathapala [2] provides the outline of the current status and future potential of biomass gasification technology in Sri Lanka. This article highlights the importance of biomass, government initiatives, and key institutions. The author concludes his study by emphasizing that there will be a rapid increase in the demand for biomass. Further, it is noted that there are only very few studies have been conducted in this specific area. Therefore, this study is aimed at evaluating the trends in biomass usage, capacities, consumption levels, and the materials used to determine the policy gaps, challenges and barriers in related to biomass usage. Based on the study, the identified gaps will be bridged using paragon mechanisms in order to green the current local manufacturing sector.

2. Methodology

In this study, authors used a questionnaire based survey to collect data/ information on biomass energy. Initially, certain manufacturing plants, which manufacture products like apparels, gloves, pharmaceuticals, etc. were chosen for the study. However there were several aspects related to biomass and its usage, important key areas were chosen for the investigation. After choosing the plants and key areas, a structured questionnaire was developed.

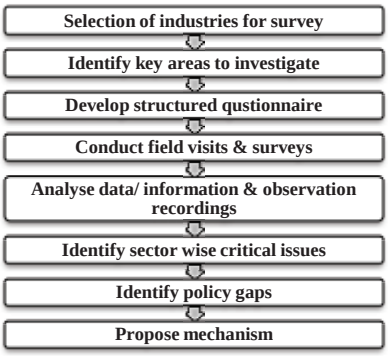

Fig. 1. Methodology

This questionnaire was designed in order to collect data/ information on areas like company profile, consumption of thermal energy, biomass supply chain, heat transfer medium and gain, problems and challenges in using biomass. Questionnaire based surveys were conducted in the selected companies as interviews with the factory managers, employees, suppliers and other necessary stakeholders. After collecting the data/ information, and observations, responses were analyzed statistically. From the statistical analyses, the common critical issues for distinct sectors were identified. Identification of the critical issues helped to determine the existing policy gaps. Finally, a mechanism was proposed to bridge the existing policy wise gaps.

3. Analyses and Results

In this section, the answers and responses for the questionnaire based survey were utilized to interpret the aspects like biomass usage, users and time of starting in different industries, sources, sector wise biomass usage, sources of biomass, medium of heat transfer, and scale of usage. Further, this section provided insight on the supply chain issues and maintenance requirements.

Initially, statistical analysis was carried out in order to evaluate the current biomass users, purpose of usage, level of usage, and the time of start [Fig. 1]. In here, manufacturers were categorized into three categories based on their products namely: textiles (includes apparel), industrial gloves and industrial medicals [Fig. 3]. From the Fig. 1, it is obvious that the trend towards using biomass for manufacturing processes in the local manufacturing sectors is raising and has marked an increase of more than 100% since 2007.

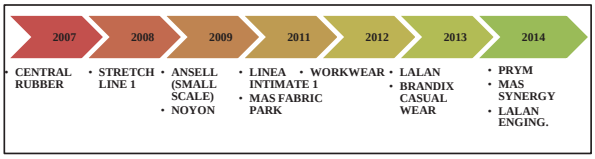

Fig. 2. Timeline of biomass users

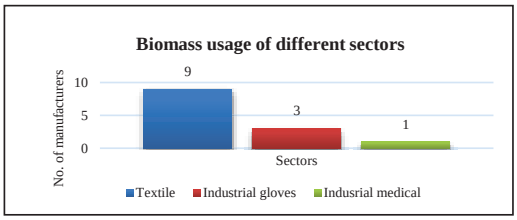

Fig. 3. Biomass usage of different sectors

Even though different industries were using biomass, this increasing trend had initiated in Sri Lankan apparel sector and then the trend was extended towards many manufacturing sectors which includes glove and some food and beverages industries.

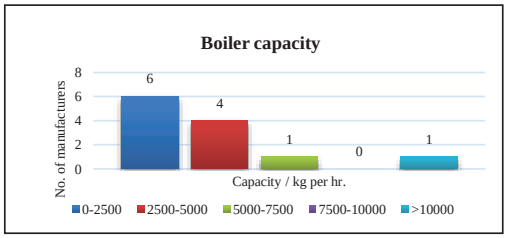

Fig. 4. Boiler Capacity

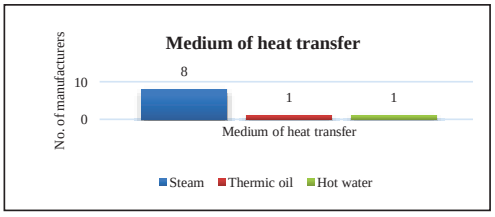

Fig. 5. Medium of Heat Transfer

Among the industries in the manufacturing sector, textile and apparel sectors are the major users of biomass for their thermal energy generation [Fig. 3]. However, traditional tea processing and dedicated coconut industry also use this type of boilers for longer period than the modern manufacturers. Even though manufacturing industries use biomass to accomplish different process requirements, thermal energy generation is given more importance. In thermal energy generation using biomass, especially in steam generation, boilers play an important role. Usage of biomass boilers vary with the companies and their requirements [Fig. 4]. Also, it was observed that 80 percent of the manufacturers use steam as the medium of heat transfer.

Though the industries have the capability of installing such boilers, they face several issues in related to the supply chain and the maintenance. When considering the supply chain, issues like level and quality of supply, finding suppliers, and inspection methodologies had created uncertainties. Fig. 6 shows the different sources used as biomass in local industries and it is notable that wood and related by products are commonly used. These wood and related sources are categorized into three as grown, forest and by products and the number of corresponding suppliers are represented in Fig. 6.

Fig. 8 represents the inspection methods which are revealed based on the survey. Though biomass is environmental friendly it is vital to evaluate the green house gas emissions caused during the transportation of the biomass. Therefore the distance between the suppliers and the factory and the warehouse facilities are estimated.

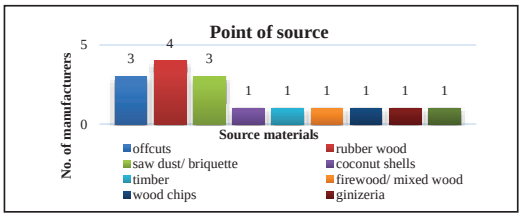

Fig. 6. Sources used as Biomass in Sri Lanka

Fig. 7. Wood sources and the Suppliers

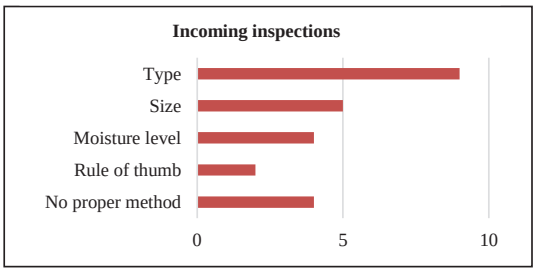

Fig. 8. Inspection Methodologies

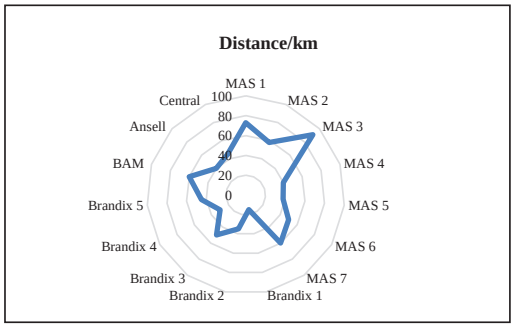

Fig. 9. Distance between the supplier and the factory

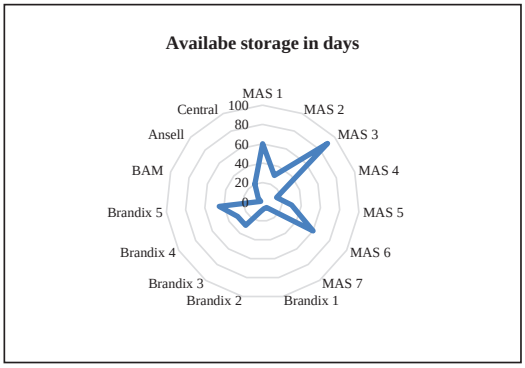

Fig. 10. Biomass Warehouse Capacity (In days)

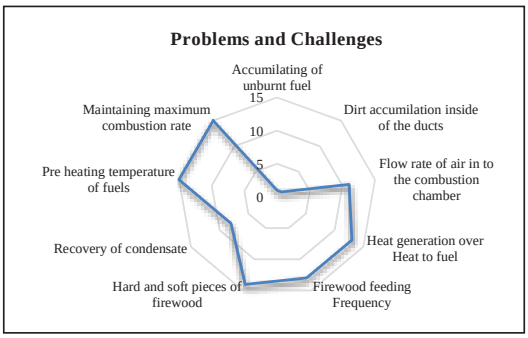

Fig. 11. Problems and challenges of biomass boilers

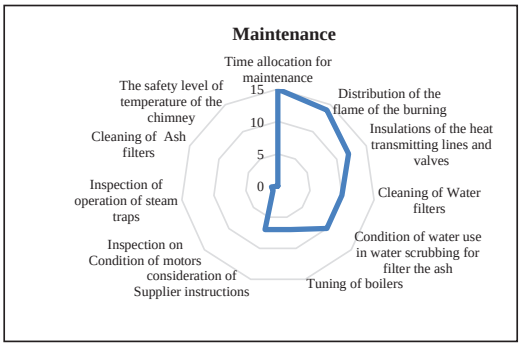

Fig. 12. Maintenance of biomass boilers

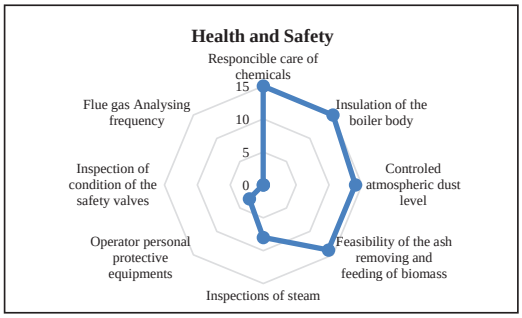

Fig. 13. Health and Safety aspects

Apart form the supply chain issues, maintenance, challenges and safety related issues too have negative impacts on current users and the future biomass users. Therefore, authors have interpreted the issues on maintenance and safety in order to bridge the gaps in future.

- Inspecting the operations of the steam traps and motor conditions
- Considering the supplier instructions
- Boiler tuning

Even though health and safety aspects related to biomass energy generation are highly emphasized globally it is blatant that in Sri Lanka the importance given to health and safety is insignificant. Most of the manufacturers have not analysed the frequency of the flue gas. Ineffective practice of personal protective equipment is another commonly notable issues in these industries. It is also observed that the manufacturers carry poor inspections for steam leaks, and for the condition of the safety valves. Further, local manufacturing sector faces different challenges and problems. Fig. 11 presents the overview of the challenges and problems faced in the industry in related to thermal energy generation. Maintaining the maximum combustion rate, inconsistency of materials used for combustion, lack of heat of generation from the material, and maintain the frequency of firewood feeding are few of the major issues.

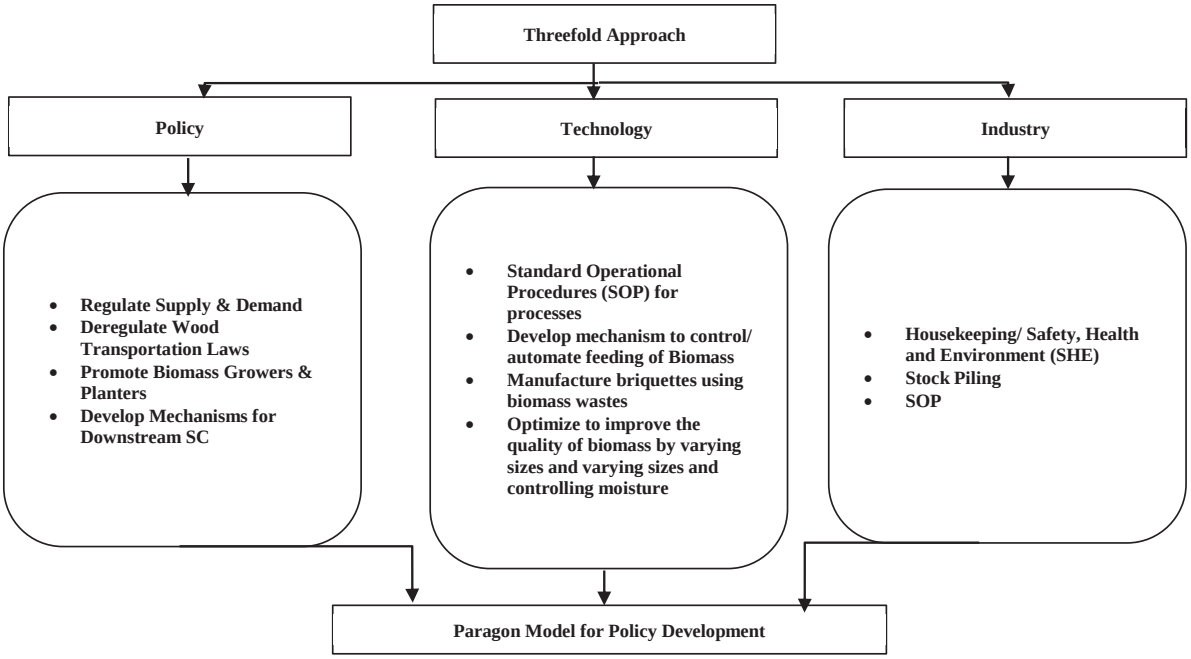

Fig. 14. Proposed Paragon Model for Policy Development

4. Conclusions

Several conclusions can be made based on the analyses and the results obtained in the previous section. From Fig. 12, it can be revealed that though there was sufficient time for maintenance purposes the following maintenance related activities are not properly performed.

- Maintaining the safety level of the temperature of the chimney
- Cleaning the ash filters

Therefore, it can be concluded that there are significant amount of works to be done in streamlining the operations of the biomass boilers. When supply of raw material is concerned, currently there are adequate amounts of plants in and around, within 60 km of distance in average. The main source of biomass come from wood saw mills off cuts and as up rooted rubber logs.

However, based on the current rate of consumption of approximately 280 tons per day, when tea and desiccated coconut industry also concerned, in future there will be scarcity for the biomass in Sri Lanka. However, further studies should

be carried out to identify the saturation levels of usage, availability and yielding patterns etc. Based on the surveys and interpretations a paragon model for policy development is proposed based on a threefold approach. This model [Fig. 14] is classified into policy, technology, and industry. In each category required steps to be followed have been recommended in order to promote biomass usage in the local manufacturing sector.

5. Limitations and Recommendations

Since, few of the local manufacturers use biomass boilers the selected sample size was limited to a small number. There can be variations in the survey responses provided by the respondents and the responses are provided orally without any witnesses. Since, thermal energy generation using biomass generation is becoming more popular further studies can be carried out in order to cater the energy requirements of manufacturing sector using biomass.

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